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*Some Recent Additions to our Knowledge of the Structure of the
Marine Polyzoa.*

[Read May 24, 1879.]

IN following the course which I have hitherto chosen of making the address given at our Anniversary Meeting an exponent of recent progress in certain departments of biological science, I propose in the present instance to call your attention to some additions to our knowledge of the marine Polyzoa. The shortness of the time at my disposal compels me to omit all reference to the embryological researches of which these animals have of late years been the subject; the facts which I am about to bring before you must therefore be confined to those of a purely structural character.

I. STRUCTURE OF THE ENDOPROCTAL POLYZOEA.

Nitsche, several years ago, contributed some very important facts on the anatomy of *Pedicellina* and of *Loxosoma**. He

* Sitzungsberichte der Gessellsch. naturforsch. Freunde zu Berlin, 1869, and Zeitschr. f. wissensch. Zoolog. vol. xx. 1871.

especially called attention to the relations of the intestine, which in these genera opens, like the mouth, within the tentacular crown. This character thus becomes the index of a very distinct type of structure, in accordance with which Nitsche divides the Polyzoa into two great sections:—the ENDOPROCTA, in which, as in *Pedicellina*, the intestine opens within the tentacular crown; and the ECTOPROCTA, in which, as in the great majority of the Polyzoa, it opens outside of the crown.

Besides the long-known *Pedicellina* and the more recently discovered *Loxosoma* of Keferstein and Ciaparède, the group of the Endoprocta now embraces the beautiful freshwater genus URNATELLA, described by Leidy*; while to the same group must be referred the remarkable marine genus ASCOPODARIA, Busk MS., determined and carefully investigated by Busk in specimens from the 'Challenger' Expedition, but not yet made the subject of a published notice.

Loxosoma has recently been studied by Oscar Schmidt †, who believes that he finds evidence that the apparent buds in this genus are really eggs detached from the ovary and developed on the body of the parent—a view which cannot be reconciled with other observations, especially those of Nitsche and of Salensky, who found such buds borne by other buds, in which, in consequence of their immature state, no ova could have as yet existed.

Salensky ‡ has described two new species of *Loxosoma*, and has made some important observations regarding the structure of this genus. Like all the other endoproctal forms, *Loxosoma* consists of a cup-shaped body supported on a peduncle. The peduncle consists of a parenchyma and a muscular layer surrounded by a cellular layer (endocyst), which is overlain by a homogeneous membranous layer (ectocyst). Its form differs much in the two species described by him. In one (*L. Tethyæ*) the peduncle is provided with a terminal gland-like organ; in the other (*L. crassicauda*) no such organ exists. *L. crassicauda*, however, fixes itself by means of a hardened homogeneous secretion, probably produced while the animal is young, and before the disappearance of the peduncular gland. The fixation of the animal by means of such a secretion seems to be characteristic of the species; for the

* "On *Urnatella gracilis*," in Proc. Acad. Sc. Philad. vol. vii. p. 191 (1854).

† Arch. f. mikr. Anat. Bd. xii. p. 1 (1875).

‡ Salensky, "Études sur les Bryozoaires Entoproctes," Ann. Sc. Nat. 6^{me} sér. tome v. 1877.

other *Loxosomas*, which in their adult state are destitute of the gland (*L. singulare* and *L. Kefersteini*), form no such secretion, but fix themselves by means of a sucker which terminates the peduncle.

The peduncular gland of *L. Tethyæ* is imbedded in a three-lobed terminal enlargement of the peduncle, and is composed of five or six large pyriform cells, with large nucleus. Each of these cells is prolonged into a very fine canal that unites with its fellows into a common tube, which traverses the middle lobe of the peduncular enlargement, and here opens externally by a pore.

It is a remarkable fact that even the species of *Loxosoma* which when adult do not possess the peduncular gland, have it when young. The observations of Nitsche have proved this for *L. Kefersteini*; and Salensky has confirmed it in the case of *L. crassicauda*, and Vogt in that of *L. phascalosomatum*.

The cup-shaped body of *Loxosoma* has its margin directed obliquely to the vertical axis, thus differing from the condition of the same part in the other genera, where the margin of the cup is transverse to the axis. Its wall consists, like that of the peduncle, of a layer of nucleated cells which forms the endocyst, overlain by a homogeneous membrane which corresponds to the ectocyst.

The body-cavity, as in all the Endoprocta, is filled with a continuous parenchyma. This consists of cells apparently destitute of membrane and provided with processes, which, by their union with one another, form a network between the body-walls and the contained organs—a condition which would seem to be universal among the Endoprocta, and which separates them by a well-marked character from the Ectoprocta.

The form of the tentacles is that of a prism whose inner or oral side is provided with a ciliated groove. The outer side is composed of a layer of flattened cells, quite similar to those forming the outer layer of the body-walls. The axis of the tentacle is occupied by a parenchymatous tissue like that which fills all the body of the animal.

Large unicellular glands are described by Salensky as dispersed in the body-wall of *L. crassicauda* and *L. Tethyæ*. They are easily detected, being of a blackish colour and in considerable number. They occur chiefly at the edge of the cup and base of the tentacles, and consist of pyriform cells having their narrow ends turned towards the free surface of the body. Each cell is filled with a brownish finely granular matter enveloping a spherical nucleus.

The muscles are nearly confined to the peduncle. Only a few fibres are found under the integument in the body, into which they are continued from the well-developed muscles of the peduncle. As in all the Endoprocta, the muscles which in the Ectoprocta are engaged in the retraction of the polypide are entirely absent.

Kowalewsky believed that the digestive canal of *L. neapolitanum* had but a single orifice common to the functions of ingestion and egestion—an error which Salensky rectifies by pointing out the difficulty of observing the commencement of the œsophagus from the point of view in which this part had been sought for by Kowalewsky, namely from the ventral side of the body.

Salensky has drawn attention to a remarkable gland-like apparatus unnoticed by other observers. It has the form of two bunches of cells plunged in the parenchyma of the body, one on each side of the intestine. The cells in each bunch are eight in number, of an ovoid figure, and consist of a transparent protoplasm apparently destitute of nucleus, and surrounded by a delicate membrane. Each cell is carried on a tubular peduncle, which is a continuation of its membrane; and all the peduncles of each bunch unite into a common canal, which opens on the side of the body by a very minute orifice. Salensky regards these gland-like organs as having an excretory function, probably renal; and it is impossible not to see in them bodies of great morphological significance, which admit of a comparison with the segmental organs of worms, and have an important bearing on the vexed question of the Vermal relations of the Polyzoa.

Salensky has further succeeded in demonstrating in *Loxosoma* a central nervous system, in the form of a ganglion which is placed above the stomach, between the end of the œsophagus and the beginning of the intestine. It is of an oval shape, and gives off nerves in different directions. Most of these lose themselves in the parenchymatous tissue of the body. The largest direct themselves from the two sides of the ganglion to the dorsal part of the animal. Each of these, besides giving off many lateral branches, presents in the middle of its course a small thickening composed exclusively of nerve-cells, and, on approaching the integument, at first attenuates and then enlarges into a pyriform knot, which becomes enclosed in one of a number of tubercles which form elevations of the integument on the dorsal part of the body, on each side of the longitudinal axis. These are doubtless sense-

organs. Each carries on its summit a bunch of immovable setæ. The cavity of the tubercle is filled by the pyriform nerve-knot, which thus lies just under the surface of the integument, and is in contact with the bases of the setæ. Salensky compares these organs with the setigerous calcar of the Rotifera, and points to a close correspondence of structure between the two.

Nearly simultaneously with Salensky, and quite independently, Vogt* describes another previously unnoticed species of *Loxosoma*. It occurs parasitically in small tufts on the caudal extremity of two species of *Phascolosoma*, a genus of worms, and is hence named by its discoverer *Loxosoma phascolosomatum*.

The oblique direction of the cup-like body by which all the species of *Loxosoma* are distinguished, has suggested to Vogt a comparison to the hood of a cloak tied in front by a string. The space within the hood he names the vestibule; it contains the mouth, anus, and place of exit of the generative organs.

The peduncular gland observed in certain other species of *Loxosoma* is altogether absent in the adult state of *L. phascolosomatum*, though it exists in the larva. Vogt further describes setigerous papillæ which he regards as organs of sense. Unlike the similar organs described by Salensky, these are only two in number, one on each side of the body. Vogt, however, has failed in his attempts to find any trace of a central nervous system.

The mouth, which, in the form of a very wide funnel, opens into the vestibule at the base of the tentacular crown, is provided with two projecting lips, one a button-shaped prominence on the ventral side, the other, longer and hook-shaped, on the dorsal, where it projects into the vestibule.

Vogt has convinced himself that *L. phascolosomatum* is diœcious. He describes in the male a thick-walled sac, which lies in the mesial line over the stomach, and which becomes filled with spermatozoa. This communicates, by two very short canals, with two gland-like organs, which are situated one on each side of the stomach, and which he regards as testes, in whose cells the spermatozoa are generated before passing into the median seminal receptacle. He has seen the spermatozoa expelled from this receptacle into the cavity of the vestibule, and has noticed them escaping thence into the surrounding water.

* Carl Vogt, "Sur le Loxosome des Phascolosomes," Archives de Zoologie expérimentale, 1877. See also a translation and condensation of that memoir by Hincks in Quart. Journ. Micr. Sc. vol. xvii. new series.

The ovaries, according to Vogt, occupy in the female exactly the same position as the testes in the male. The ova are expelled from them one after the other, and pass into the vestibule, which may become loaded with them. Here they run through certain early stages of development, and are ultimately expelled as ciliated larvæ.

One can scarcely overlook the close correspondence between the organs here described by Vogt as ovaries and testes and those which Salensky describes as a glandular apparatus with a probable excretory function.

Loxosoma is regarded by Vogt as an archetypal form, from which that of the ordinary Polyzoa has been derived by successive modifications.

II. HYPOPHORELLA EXPANSA.

We are indebted to Ehlers for a valuable memoir on a very remarkable burrowing polyzoon, to which he gives the name of *Hypophorella expansa**

He met with it on the coast of Spickeroog, where it occurred in burrows which it had formed in the thickness of the tube-wall of *Terebella conchilega*. The completely developed colony is composed of two kinds of dissimilar members or zooids. Of these the one set is destitute of intestinal canal, and is capable of only non-sexual reproduction, while the other has a developed intestinal tract, as well as sexual organs which give rise to fertile eggs, non-sexual reproduction occurring here only exceptionally. The intestineless members have the shape of long thin threads; he designates them as "Stengelthiere." The intestine-bearing members are urn-shaped, or flask-shaped, and are called by Ehlers "Nährthiere."

The filiform zooids, or "Stengelglieder," form stolons by which the colony extends itself, and on which the nutritive zooids or "Nährthiere" are borne. The starting-point of the entire colony is a thread-like Stengelglied, which is developed from the larva. From the distal or growing end of this are produced in linear order a succession of similar filiform zooids, which together form a progressive filament, which burrows between the layers of the *Terebella*-tube. The distal end of this filament thus represents the youngest, as yet undeveloped filiform zooid.

From the single members (Glieder) of this long filiform stolon

* E. Ehlers. "*Hypophorella expansa*, ein Beitrag zur Kenntniss der minierenden Polyzoa," Abhandl. der königl. Gesellsch. der Wissenschaften, 1876.

(if we except the oldest or basal member and the youngest or terminal) there spring in regular order lateral shoots, by which the stolon sends out on one side a series of filiform zooids like those of which it is itself composed, and on the other the zooids which form the flask-shaped or nutritive members of the colony. Each component member of the burrowing stolon may thus carry on its distal end two opposite zooids, one of which is a filiform zooid, the other a nutritive zooid.

The filiform zooids push themselves between the layers of the tube-wall of the Annelid; the nutritive zooids, on the other hand, perforate the inner layer, forming a circular orifice through which the animal projects its crown of tentacles into the lumen of the tube.

The component members of the stolon are dilated at their distal ends (where they carry the two opposite zooids) into a kind of flattened capsule. In the rest of their extent they present, under a low magnifying power, an obscurely ringed appearance. Each forms a completely closed tube filled with a clear non-corpusculated liquid. The wall is composed of a laminated chitinous ectocyst lined by a soft endocyst*, in which granules and fusiform nuclei lie embedded, but which shows no differentiation into distinct cells. In the capsule-like dilatations there occur peculiar structures in the form of glistening, thin, straight bands, which are stretched from one side of the capsule to the other, and at their points of attachment pass into the protoplasmic substance of the endocyst. Each of these bands contains a very distinct nucleus, but shows no further differentiation. They closely resemble muscular fibres such as are developed in the nutritive zooids; but Ehlers could obtain no evidence of contraction.

Unlike the filiform zooids, the nutritive zooids possess in most respects the typical structure of a Gymnolæmatous polyzoon. A peculiarity by which they are characterized consists in the presence of two hollow horn-like processes, which arise, one on each side, a little behind the orifice of the zoœcium. Nothing can be asserted as to the significance of these processes. Their cavity does not appear to communicate with that of the zoœcium.

The body-wall of the nutritive zooids consists of the same layers as that of the filiform zooids; the endocyst, however, is seen to

* Ehlers, on grounds which cannot be regarded as sufficient, refuses to employ the terms "ectocyst" and "endocyst," as well as "polypide," "zoœcium," and others now generally accepted by writers on the Polyzoa.

be much more distinctly differentiated into cell-territories. Embedded in its substance are oval nuclei, each of which is surrounded by a small area of protoplasm, from which fine filiform off-runners pass out to unite with neighbouring ones. We thus obtain the appearance of a set of stellate cells united by their radiating extensions, and believed by Ehlers to undergo slow changes of form. Ehlers believes these to be of the same nature as the stellate cells which Claparède* has observed in the walls of the marine Polyzoa, and to which he has referred the canal-system noticed by Smitt† in the body-wall of *Membranpora pilosa*. Similar cells have been described by Nitsche in the marine Polyzoa.

In the completely retracted state of the polypide the appearance of a radially striated circular disk, perforated in the centre, may be seen a little within the orifice of invagination stretching across the tentacular sheath in the manner of a diaphragm. In the exerted state of the polypide this appearance is seen to be due to folds in the wall of the tentacular sheath; and this part of the sheath will then be found to form a transparent, short, cylindrical neck with longitudinal ridges.

It will thus be seen that the great interest of Ehlers's memoir consists in its making known to us a type of Polyzoa in which there is expressed a strongly marked dimorphism of the zooids with distinct functions allocated to each of the two forms which thus make up the complete colony.

* Claparède, "Beiträge zur Anat. und Entwickel. der Seebryozoen," Zeit. f. wissens. Zool. 1871.

† Smitt, "Om Hafs-Bryozoernas utveckling," Œfversigt, 1865.
